

**Amendments to the Specification:**

Please add the following new paragraph before paragraph [0027]. Note: paragraph numbers are those of the Specification as filed with the Preliminary Amendment.

**[0026.1]** The present invention is described with reference to the accompanying drawings. In the drawings, like reference numbers indicate identical or functionally similar elements.

Please replace paragraph [0045] with the following amended paragraph:

**[0045]** Each chamber 11 is bounded by two pistons 3 in the torus 10. As shown in FIG. 2A, the cross-sectional area of the pistons 3 corresponds substantially to the internal cross-sectional area of the torus 10, such that the pistons 3 provide an effective seal between the chambers 11. As mentioned above, this description of the toroidal IC engine 100 is based on a four-stroke engine having eight chambers. Accordingly, the pistons 3 include four intake-valve pistons 2 and four exhaust-valve pistons 4. Note that in the following description, the reference designation 3 shall refer to a piston in general, that is, regardless of its function as an intake-valve piston 2 or an exhaust-valve piston 4. The intake-valve pistons 2 are mounted on the concave (inside) wall of the inner engine ring 10B, spaced 90 degrees apart. Similarly, the exhaust-valve pistons 4 are mounted on the concave wall of the outer engine ring 10A, also spaced 90 degrees apart. Each of the pistons 3 is connected via a port to a passage that connects to a manifold, thus, the intake-valve pistons 2 are connected to an intake manifold 20 ~~or and~~ and the exhaust-valve pistons 4 to an exhaust manifold 40. These connections will be discussed below.

Please replace paragraph [0046] with the following amended paragraph:

**[0046]** FIGS. 3A – 3D illustrate the changes in size of the eight chambers 11 throughout the four-stroke engine cycle. The eight chambers 11 include: two combustion chambers 12A, 12B; two intake chambers 14A, 14B; two compression

chambers 16A,16B, and two exhaust chambers 18A,18B. Note that in the following description, reference designation 11 shall refer to a chamber in general, regardless of its function during the engine cycle. Each chamber 11 is bounded by two pistons 3, one being the intake-valve piston 2, and one the exhaust-valve piston 4. For the sake of clarity, the pistons 2, 4 are shown without the manifolds 20, 40. During operation, pressure changes occurring in the chambers 11 act against the faces of the pistons 3. For example, when combustion occurs in the two combustion chambers 12A,12B, the intake-valve pistons 2 and the exhaust-valve pistons 4 bounding the two combustion chambers 12A,12B are forced apart, causing the outer engine ring 10A and the inner engine ring 10B to move in opposite directions, that is, to counter-rotate as indicated by ring-rotation arrows 9A and 9B 6A and 6B. For illustration purposes only, pairs of chambers, independent of stroke cycle, are identified in FIGS. 3A – 3D as A,A'; B,B'; C,C'; and D,D'.

Please replace paragraph [0047] with the following amended paragraph:

**[0047]** Each of the FIGS. 3A – 3D illustrates the relative position of the chambers 11 an instant before a stroke. In FIG. 3A, the chambers A,A' represent the combustion chambers 12A,12B just before combustion occurs. The pistons 2,4 bounding the combustion chambers 12A,12B and the intake chambers 14A,14B are close together (at TDC) and the pistons 2,4 bounding the compression chambers 16A,16B and exhaust chambers 18A,18B are far apart (at BDC). Combustion in chambers 12A,12B forces the pistons 2,4 bounding these chambers apart. FIG. 3B shows the chambers A,A' just after combustion has occurred. Increased pressure forces against the faces of the two pistons 2,4 forces the pistons 2,4 to move in opposite directions, as indicated by ring-rotation arrows 9A,9B 6A, 6B. All intake-valve pistons 2 in the inner engine ring 10B move together and all exhaust-valve pistons 4 in the outer engine ring 10A move together. As a result, Chambers A,A' now represent exhaust chambers 18A,18B just before the exhaust stroke occurs in these chambers. It should be clear from this

description that each pair of chambers A,A'; B,B'; C,C'; and D,D' undergoes each one of the four strokes as the toroidal IC engine 100 goes through one cycle.

Please replace paragraph [0049] with the following amended paragraph.

**[0049]** FIG. 4 illustrates a system of mounting the pistons 3 in the torus 10. The intake manifold 20 and the exhaust manifold 40 are shown only schematically and partially. The exhaust manifold 40 is shown to be greater in diameter than the intake manifold 20. This is for illustration purposes and is not a limiting feature of the invention. Four pistons 3 that are the intake-valve pistons 2 are connected to the intake manifold 20 and are fixedly mounted in the inner engine ring 10B. Seal rings 5 encircle the portion of the intake-valve pistons 2 that extend into the outer engine ring 10A. Four pistons 3 that are the exhaust-valve pistons 4 are connected to the exhaust manifold 40 and are fixedly mounted in the outer engine ring 10A. Seal rings 5 encircle the portion of the exhaust-valve pistons 4 that extend into the inner engine ring 10B. As described with FIGS. 3A – 3D, the combustion pressures force the exhaust-valve pistons 4, which are all fixedly mounted to the outer engine ring 10A, to move in one direction, which forces the outer engine ring 10A to move in one direction, while the forces on the intake-valve pistons 2, which are all fixedly mounted to the inner engine ring 10B, force the intake-valve pistons 2 to move in the opposite direction, thereby forcing the inner engine ring 10B to rotate in the opposite direction. The seal rings 5 are best seen in FIG. 6. Half of any one piston 3 that is affixed to one engine ring, for example, the outer engine ring 10A, while the other half of the piston 3 extends into the other engine ring, i.e., the inner engine ring 10B. The piston 3 and must be able to slide along the inner wall of the inner engine ring 10B, without causing undue friction, while at the same time sealing the chamber against gas leakage. In other words, a first half-portion of the piston 3 is fixedly attached to one of the engine rings 10A or 10B, while a second half-portion of the same piston 3 slides along the inner wall of the other of the engine rings 10B or 10A. The seal ring 5 is provided on the second half-portion of the piston 3, as shown in FIGS. 6 and 9.

Please replace paragraph [0050] with the following amended paragraph:

**[0050]** It has been mentioned above that the intake valves and exhaust valves are assembled in the piston faces 3A, with only one valve 7 on one piston face 3A. The most suitable types of valves are slot and slide type valves. FIG. 5A illustrates a valve 7 slider valve 7B, placed in the face 3A of the piston 3 and a port 9, in particular, in intake port 9B, that connects the valve 7 to a passage to the intake manifold 20. ~~or the exhaust manifold 40. It has been mentioned above that the intake valves and exhaust valves are assembled in the piston faces 3A, with only one valve 7 on one piston face 3A. The most suitable types of valves are slot and slide type valves. FIG. 5A shows a slider valve 7B assembled in the piston face 3A. FIG. 5B shows a slot valve 7A mounted in an exhaust port 9A.~~

Please replace paragraph [0051] with the following amended paragraph:

**[0051]** FIG. 6 is a perspective view of one of the exhaust-valve pistons 4, assembled in the outer engine ring 10A. The inner engine ring 10B is not shown in this view, for purposes of illustration. As discussed above, each piston 3 has two piston faces 3A, 3B and, specifically, each intake-valve piston 2 has two piston faces 2A, 2B, and each exhaust-valve piston 4 two piston faces 4A, 4B. As shown in FIG. 6, the seal rings 5 are provided on the portion of the exhaust-valve piston 4 that extends into the inner engine ring 10B. ~~An exhaust port 9 is shown in the wall of the exhaust-valve piston 4 for connecting it to the exhaust manifold 40 (not shown), and the slider valve 7B is assembled in the exhaust-valve piston face 4A.~~

Please replace paragraph [0052] with the following amended paragraph:

**[0052]** ~~FIG. 7 illustrates~~ FIGS. 7 and 9 illustrate one embodiment of the toroidal IC engine 100 according to the invention, showing the intake manifold 20 and the exhaust manifold 40 mounted on a shaft 30, with the toroidal IC engine 100 supported on the shaft between the manifolds 20, 40. As seen, ~~an arm 20A extends from the intake manifold 20 to the inner engine ring 10B and connects to an intake port 9B on the~~

~~intake-valve piston 2~~; an arm 40A extends from the exhaust manifold 40 to the outer engine ring 10A and connects to the exhaust port 9A on the exhaust-valve piston 4. In FIG. 9 it can be seen that the four exhaust-valve pistons 4 are fixedly attached to the outer ring 10A, 90 degrees apart from each other, while the four intake-valve pistons 2 are fixedly attached to the inner ring 10B, also 90 degrees apart from each other. Openings are provided in the engine ring 10 at the piston attachment points to provide an open channel for gas flow into or out of the respective pistons 4, 2.